



# Cost Estimates for Commodities

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CD-2/3a Director's Review of NOvA  
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# Strategy

- Commodities drive the cost of NO<sub>v</sub>A
- Small changes in unit costs can have big implications
- We have spent a great deal of time and effort to understand the cost and contingency of the commodities.
- We have solicited quotes for the integration near detector prototype for delivery in 2007.
- The quotes included a unilateral option for delivery of full quantities for the full NO<sub>v</sub>A near and far detectors beginning in 2008.
- Quantities have changed as we have de-scoped the detector.



# Summary Table

For 18 kt

	Quantity	Unit Cost	Contingency	Contingency Rule
Pseudocumene	215,000 gal	\$1.05/lb	25%	#3
Mineral Oil	3.7M gal	\$2.98/gal	28%	#2 + crude oil risk.
Mineral Oil Delivery	3.7M gal ~185 railcars	\$0.18/gal	26%	#2 + crude oil risk
Trucking Scintillator	3.9M gal ~560 truckloads	\$2075/trip	29%	#2 + crude oil risk
Waveshifters	15,269 kg PPO 214 kg bis-MSB	\$197/kg PPO \$1210/kg bis-MSB	25%	#2 + crude risk
WLS Fiber	18,000 km	\$0.63/m	28%	#3 + exchange rate
PVC Resin	12M lbs	\$0.984/lb	30%	#2 + crude + natural gas
Extrusions	28,900 16-cell extrusions	\$0.92/lb	25%	#4



# M&S Contingency Rules

NOvA-doc-616

- 1) 0% on items that have been completed
- 2) 10-15% on items that have already been purchased at least once (perhaps in small quantities) or items for which there is a very firm quote and for which there is more than one potential vendor.
- 3) 15-25% on items that have already been purchased at least once (perhaps in small quantities) or items for which there is a very firm quote but for which there is likely to be only one vendor.
- 4) 25-50% on items that can be readily estimated from a reasonably detailed design or for which there exists a very close “analogous system”, with well understood costs.
- 5) 50-70% on items for which only a conceptual design exists.
- 6) 50-70% for items that have unproven yields or for which there are unique issues (e.g. an uncertain cost and a single vendor).
- 7) 70-100% for items that do not yet have a detailed conceptual design.



# Mineral Oil

- Obtained quotes from 2 suppliers in Dec 2005 for 6.6M gal in response to RFP.
- Quotes were indexed to Conoco 70 viscosity paraffinic Gulf Coast Group II Base oil from the *Lube Report*
- Obtained new quotes for smaller quantities in May 2007.
- **Same price after indexing. Well within our contingency after indexing.**
- **Contingency of 28% based on firm quotes and risk analysis on the connection to potential volatility of crude oil.**

	Dec. `05 6.6M gal 30 kt	May `07 3.7M gal 18 kt	May `07 3.2M gal 15 kt	Dec `05 + \$0.05 Indexed to May '07
Base Oil Index Price	\$2.62/gal	\$2.97/gal	\$2.97/gal	\$2.97/gal
Vender A	\$2.98/gal	\$3.33/gal	\$3.33/gal	\$3.33/gal
Vender B	\$2.96/gal	\$3.36/gal	\$3.36/gal	\$3.36/gal

We know how much this costs, how it scales and we have a contingency that covers us.



# Mineral Oil Shipping

- Shipping costs broken out separately
- We have quotes for rail shipments of mineral oil to Fermilab from the gulf.
  - Toll blender in Chicago area about the same distance.
- Shipping is indexed by BNSF fuel surcharge, linked to price of diesel fuel:
  - \$2.45/gal 12/05 - \$2.78/gal today. Surcharge up from 16% to 20%
  - Well within our contingency

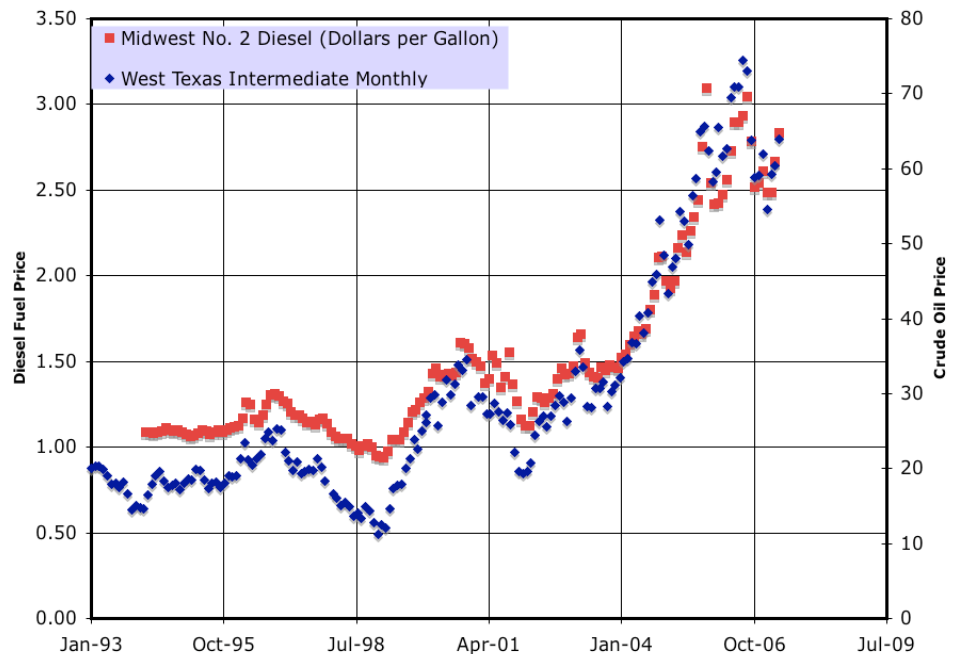
## Prior Period's Avg.

### Price of Diesel between:

\$2.40 - \$2.439  
 \$2.44 - \$2.479  
 \$2.48 - \$2.519  
 \$2.52 - \$2.559  
 \$2.56 - \$2.599  
 \$2.60 - \$2.639  
 \$2.64 - \$2.679  
 \$2.68 - \$2.719  
 \$2.72 - \$2.759  
 \$2.76 - \$2.799  
 \$2.80 - \$2.839  
 \$2.84 - \$2.879  
 ...

### Fuel Surcharge:

15.5%  
 16.0%  
 16.5%  
 17.0%  
 17.5%  
 18.0%  
 18.5%  
 19.0%  
 19.5%  
 20.0%  
 20.5%  
 21.0%



We know how diesel tracks crude.  
 Combine with our model for crude oil  
 prices to Monte Carlo shipping contingency



# Pseudocumene

- Two known suppliers. One in China, one in US.
  - We have tested both and they are indistinguishable.
  - Same base cost, but shipping from China doubles cost.
  - Can only get a 90 day quote from US supplier.
- We cannot find any information on linkage to crude oil.
- We have quotes from the US supplier 16 months apart for same price in spite of significantly smaller quantity.
- We have purchased 11 55-gallon drums

	Jan. 2006 <u>11 55-gal drums</u>	Jan. 2006 <u>32 railcars</u>	May 2007 <u>10 railcars</u>
Pseudocumene quote	\$1.15/lb	\$1.05/lb	\$1.05/lb

- Based on NOvA contingency rule # 3 (15-25% on items that have already been purchased at least once, perhaps in small quantities) we assign a contingency of 25%



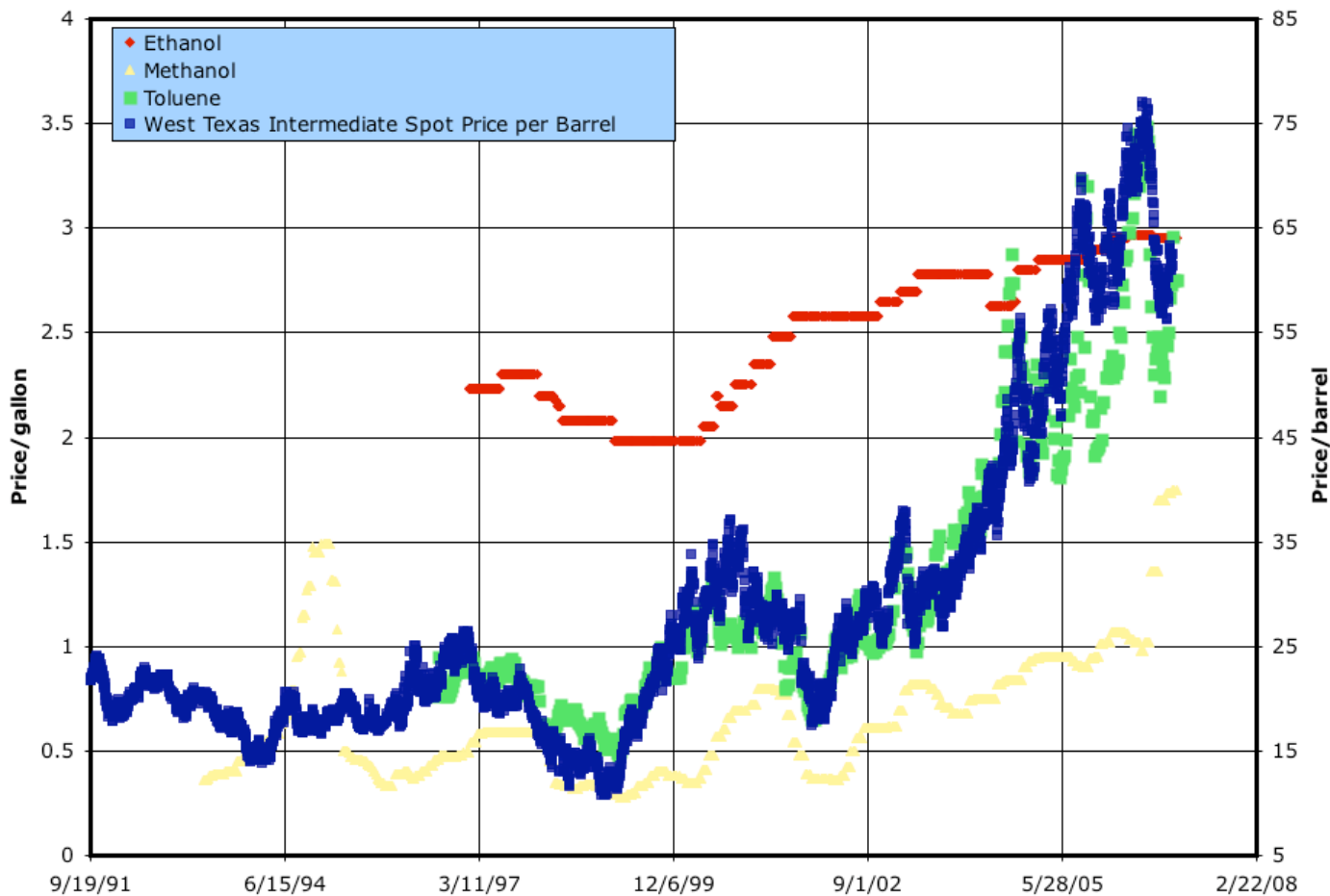
# Waveshifters

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- Firm quote, sole source US supplier who has worked with us before.
- We have obtained firm, binding quotes on several occasions as the quantities we require have changed.
- Price indexed 50% to PPI and 50% to a *market basket* of representative chemical costs.
  - Ethanol
  - Methanol
  - Toluene
- We have a firm quote for the required quantity.
- 15% flat rate contingency + Monte Carlo of risk associated with market basket chemicals results in a 25% contingency.



# Scaling Indices for Waveshifters



Toluene and Methanol correlate to crude. Ethanol does not.



# Waveshifter Prices and Quantities

Detector Mass	PPO/bis-MSB Dec. 2005 (per kg) (total)	PPO/bis-MSB May, 2006 (per kg) (total)	PPO/bis-MSB May 2007 (per kg) (total)
18 kt			\$197/\$1210 \$3.0M/\$259k
20 kt		\$189/\$1160/kg \$3.3M/\$290k	
25 kt		\$183/\$1120 \$4.1M/\$351k	
30 kt		\$178/\$1090 \$4.8M/\$410k	
30 kt × 2*	\$168/\$1020 \$9.7M/\$671k		

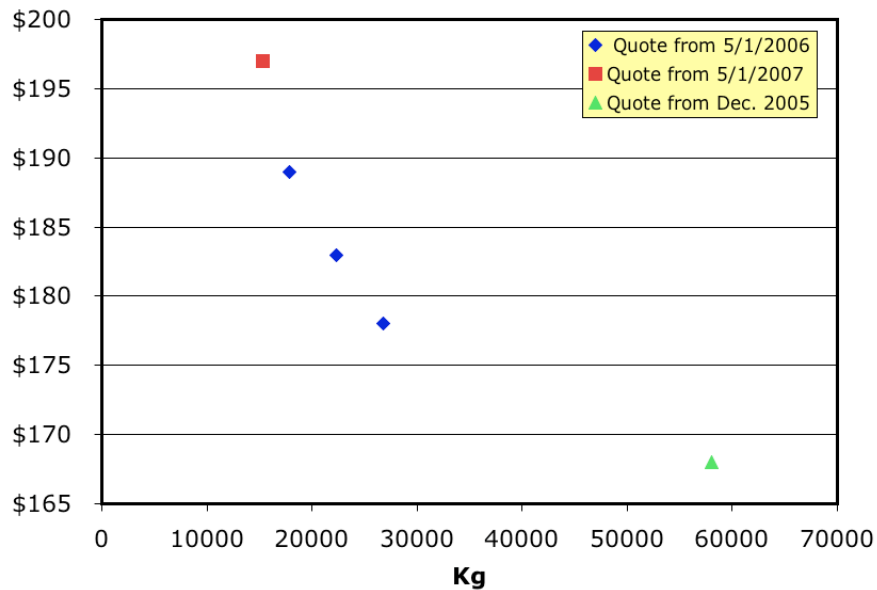
Price changes with quantity. Use latest quote for correct quantity.

\* Different scintillator mix with higher concentration of pesudocumene and waveshifters

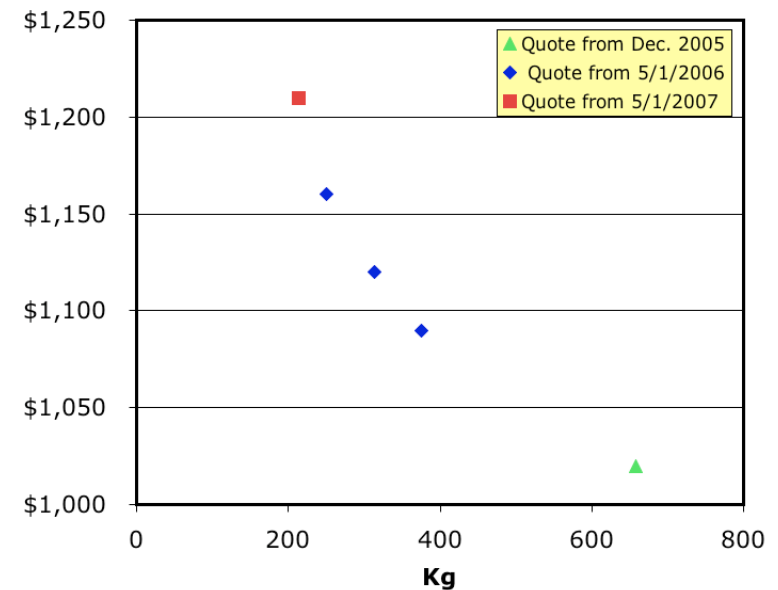


# Waveshifter Price History

**PPO Quotes vs Quantity**



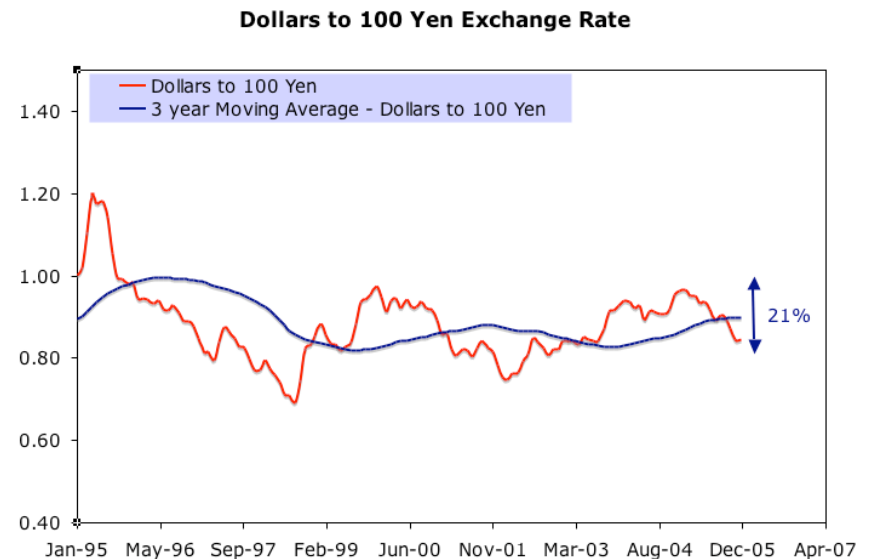
**bis-MSB Price vs Quantity**





# WLS Fiber

- Sole source foreign supplier, but one that we know well and have worked with extensively in the past.
- We have a binding quote for the required quantity.
- The quote is valid for a range of 110-120 Yen/dollar and will be adjusted if the exchange rate moves outside that range.
- Risk Management has identified currency fluctuations as a concern. A Monte Carlo calculation has been performed and additional contingency allocated for an overall contingency of 28%.





# PVC Resin

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- We do not use a standard PVC blend. We add additional  $\text{TiO}_2$  and remove/suppress ingredients that absorb light.
- We obtained quotes from 3 suppliers in July 2006 for 12,900,000 lbs of a resin that is similar to our baseline.
  - Price was \$0.984/lb
- We recently ordered 130,000 lbs of our baseline resin.
  - Price is \$0.98/lb
  - Use this number for the ~12,000,000 lbs required



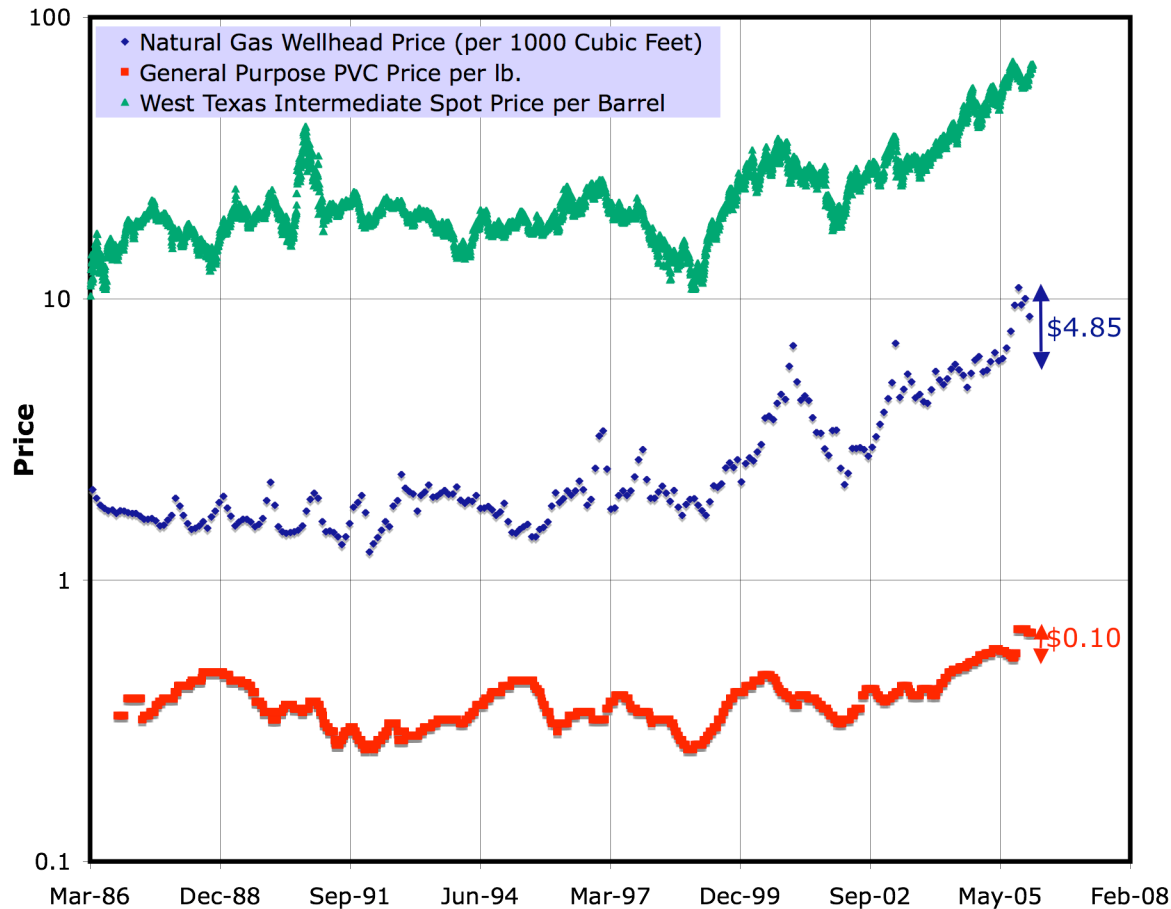
# PVC Resin

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- PVC resin is 57% chlorine by weight. The rest is hydrogen and carbon, derived from **natural gas and petroleum**.
- Most PVC is made from ethylene. Ethylene is made by cracking ethane in a reactor at about 800°C. Ethane is extracted during the refining of **natural gas**.
- **Fossil fuels** are used to power the ethane reactor.
- **Resin producer's rule of thumb is that a \$1/1000 ft<sup>3</sup> increase in natural gas prices adds 2¢/lb. to PVC.**
  - Before Katrina, natural gas was at \$6/1000 ft<sup>3</sup>; by mid October it was \$14.



# PVC Resin



During run-up in natural gas prices due to Katrina, the natural gas/PVC resin rule of thumb approximately holds.



# PVC Resin Cost

- Use recent price for 130,000 lbs purchase of \$0.98.
  - We need ~12,000,000 lbs.
- Assign flat rate contingency of 15% to resin
- Assign flat rate contingency of 30% to  $\text{TiO}_2$ 
  - Included in \$0.98 above
- Add risk-based contingency to the PVC resin due to natural gas and crude oil. Monte Carlo.
- Results in a 30% contingency.



# PVC Extrusions

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- Issued an RFP in Sept. 2005 for R&D quantities plus an option for 12,900,000 lbs of PVC extrusions. Several unknowns at the time, so we assigned a 35% contingency.
- Many things have changed since then, so we have solicited a new quote for the base plan from the extruder who won the RFP competition.
- Still a few small uncertainties including waste factor, storage, never extruded thicker walled verticals.
- Assign a flat-rate contingency of 25%.
- Delivery is indexed to diesel fuel surcharge. Monte Carlo calculation results in a 34% contingency for extrusion delivery.



# Summary

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- Commodities account for a large fraction of the TPC
- Considerable effort has been expended to obtain quotes for the various commodities and to account for the relevant risks in assigning contingency.
  - Quantities have changed as we have descoped.  
we have updated quotes for the relevant quantities.
- We know how much these items cost and we believe we have a good handle on possible changes over time.